

IN THE ABSTRACT:

Delete the abstract now of record and insert therefor the new abstract submitted herewith of on a separate sheet.

ADDITIONAL FEES:

No additional fees are believed required; however, should it be determined that a fee is due, authorization is hereby given to charge any such fee to our Deposit Account No. 01-0268.

REMARKS

In the last Office Action, the Examiner withdrew claims 2 and 5-23 from further consideration as being directed to a non-elected invention. The drawings were objected to because Figs. 12-14 are not designated with the legend "Prior Art". Claims 3 and 4 were objected to as being in improper multiple dependent form. Claims 1 and 3 were rejected under 35 U.S.C. §103(a) as being unpatentable over the Niwa et al. reference ("Niwa") disclosed on pages 2-3 of the specification.

In accordance with the present response, the specification has been suitably revised to correct informalities and to place it in better conformance with U.S. practice. Original independent claim 1 has been amended to

Attached hereto is a marked-up version of the changes made to the title, abstract, specification and claims by the current amendment. The attached pages i-xiv are captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

Applicants respectfully request reconsideration of their application in light of the following discussion.

Brief Summary of the Invention

The present invention is directed to an optical microcantilever.

Fig. 13 shows a conventional optical microcantilever. As described in the specification (pgs. 3-4), the conventional optical microcantilever shown in Fig. 13 has not been able to prevent the high loss of propagating light occurring in the optical waveguide. The loss of propagating light diminishes the ability of the optical microcantilever to propagate light efficiently toward the microscopic aperture formed at the tip of the optical waveguide. This results in the inability to generate near-field light at the microscopic aperture.

The present invention overcomes the drawbacks of the conventional art. Fig. 1 shows an embodiment of an optical microcantilever 10 according to the present invention embodied in the claims. The optical microcantilever 10 comprises an

optical waveguide 2 for propagating light and has a light input/output end 8 and a free end. A tip 5 is formed at the free end of the optical waveguide 2 and has a microscopic aperture 6. According to the present invention, a reflecting member 7 (e.g., a mirror) is disposed at the free end of the optical waveguide 2 and has a generally planar surface for reflecting light propagated by the optical waveguide 2 and for guiding the reflected light towards the microscopic aperture 6 of the tip 5.

By the foregoing construction, the propagating light propagated by the optical waveguide is effectively guided by the reflecting member towards the microscopic aperture in the tip of the optical microcantilever so that near-field light is generated at the microscopic aperture.

Traversal of Prior art Rejections

Claims 1 and 3 were rejected under 35 U.S.C. §103(a) as being unpatentable over Niwa. Applicants respectfully traverse this rejection and submit that the teachings of Niwa do not disclose or suggest the subject matter recited in amended claims 1 and 3.

Amended independent claim 1 is directed to an optical microcantilever and requires an optical waveguide for propagating light incident from a light input/output end, a

tip formed at a free end of the optical waveguide and having a microscopic aperture, and a reflecting member disposed at the free end of the optical waveguide and having a generally planar surface for reflecting light propagated from the light input/output end of the optical waveguide and for guiding the reflected light towards the microscopic aperture of the tip, or for reflecting light propagated from the microscopic aperture towards the light input/output end of the optical waveguide. No corresponding structural combination is disclosed or suggested by the prior art of record.

Niwa (Fig. 13 and pages 2-3 in the specification) discloses an optical microcantilever 120 having an optical waveguide 111, a metal film 112 disposed on the surface of the optical waveguide 111, a tip 119 formed at a free end of the optical waveguide and having a microscopic aperture 113. However, Niwa does not disclose or suggest a reflecting member disposed at the free end of the optical waveguide and having a generally planar surface for reflecting light propagated from the light input/output end of the optical waveguide and for guiding the reflected light towards the microscopic aperture of the tip, or for reflecting light propagated from the microscopic aperture towards the light input/output end of the optical waveguide, as required by amended independent claim 1.

For example, in the embodiment of the present invention shown in Fig. 1, the reflecting member 7 has a planar surface which reflects light propagated from the light input/output end of the optical waveguide and guides the reflected light towards the microscopic aperture of the tip. In Niwa, however, propagated light which is reflected by the metal film 112 is not guided towards the microscopic aperture 113. Thus Niwa suffers from the disadvantage described in the specification and reiterated herein since the optical waveguide 111 of Niwa is subjected to high loss of propagating light which diminishes the ability of the optical microcantilever 120 to propagate light efficiently toward the microscopic aperture 113 with the result that near-field light cannot be generated at the microscopic aperture 113.

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claims

Claims 3 and 4 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from the references at least in the same manner as claim 1.

In view of the foregoing, applicants respectfully request that the rejection of claims 1, 3 and 4 under 35 U.S.C. §103(a) as being unpatentable over Niwa be withdrawn.

Applicants respectfully submit that new claims 24-40 also patentably distinguish from the prior art of record.

Claims 24-33 depend on and contain all of the limitations of amended independent claim 1 and, therefore, distinguish from the reference at least in the same manner as claim 1.

Moreover, there are separate grounds for patentability of dependent claims 25-26 which include the additional limitation that the entire mirror (claim 25) or reflecting member (claim 26) is generally planar. Again, no corresponding structure is disclosed or suggested by the prior art of record.

New independent claim 34 is directed to an optical microcantilever and requires an optical waveguide for propagating light and having a tip portion formed at a free end of the optical waveguide, the tip portion having a microscopic aperture, and a reflecting member disposed at the free end of the optical waveguide and having a generally planar surface for reflecting light propagated by the optical waveguide and for guiding the reflected light towards the microscopic aperture to generate near-field light at the microscopic aperture. No corresponding structural combination is disclosed or suggested by Niwa as set forth above for amended independent claim 1.

Claims 35-39 depend on and contain all of the limitations of independent claim 34 and, therefore,

distinguish from the reference at least in the same manner as claim 34.

Moreover, there are separate grounds for patentability of dependent claims 36-39 which include the additional limitation that the reflecting member forms part of the reflecting film (claims 36, 39), that the optical waveguide has a second section extending from the first section at a preselected angle relative to the longitudinal axis so that the light reflected by the reflecting member is guided towards the microscopic aperture to generate near-field light at the microscopic aperture (claim 37), and that the reflecting member is disposed on the second section of the optical waveguide (claim 38). Again, no corresponding structure is disclosed or suggested by the prior art of record.

New independent claim 40 is directed to an optical microcantilever and requires an optical waveguide for propagating light and having a longitudinal axis and a tip portion formed at a free end of the optical waveguide, the tip portion having a microscopic aperture, and a reflecting film disposed on at least a portion of the optical waveguide, the reflecting film having a generally planar surface disposed proximate the free end of the optical waveguide at a preselected angle relative to the longitudinal axis for reflecting light propagated by the optical waveguide and for



guiding the reflected light towards the microscopic aperture to generate near-field light at the microscopic aperture. Again, no corresponding structural combination is disclosed or suggested by the prior art of record.

In view of the foregoing amendments and discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

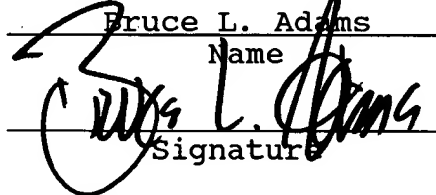
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Name

Signature

March 17, 2003

Date

ABSTRACT OF THE DISCLOSURE

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An optical microcantilever has an optical waveguide for propagating light. The optical waveguide has a tip portion formed at a free end of the optical waveguide. The tip portion having a microscopic aperture. A reflecting member is disposed at the free end of the optical waveguide and has a generally planar surface for reflecting light propagated by the optical waveguide and for guiding the reflected light towards the microscopic aperture to generate near-field light at the microscopic aperture.



VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE TITLE:

The title has been amended as follows:

OPTICAL MICROCANTILEVER[, MANUFACTURING METHOD
THEREOF, AND OPTICAL MICROCANTILEVER HOLDER]

IN THE ABSTRACT:

The original abstract has been substituted by the
following new abstract:

An optical microcantilever has an optical waveguide
for propagating light. The optical waveguide has a tip
portion formed at a free end of the optical waveguide. The
tip portion having a microscopic aperture. A reflecting
member is disposed at the free end of the optical waveguide
and has a generally planar surface for reflecting light
propagated by the optical waveguide and for guiding the
reflected light towards the microscopic aperture to generate
near-field light at the microscopic aperture.

IN THE SPECIFICATION:

Paragraph beginning at line 13 of page 4 has been amended as
follows:

In order to resolve the aforementioned problems in

the conventional art, it is [therefore the] an object of the present invention to provide an optical microcantilever bar capable of admitting and propagating light in an efficient manner, and a manufacturing method for making [this kind of] the optical microcantilever. It is a further object to provide an optical microcantilever holder for supporting the optical microcantilever bar and an optical element. It is a still further object to provide an optical microcantilever bar capable of improving an S/N ratio of a light image of a scanning near field microscope.

Heading beginning at line 21 of page 4 has been amended as follows:

[Disclosure of the Invention] SUMMARY OF THE INVENTION

Paragraph beginning at line 22 of page 4 has been amended as follows:

In order to achieve the aforementioned objects, an optical microcantilever according to a first embodiment of [claim 1] the invention is an optical microcantilever for use with a scanning near field microscope[, comprising] and comprises an optical waveguide, having a light input/output end and a free end, for propagating light, a tip formed at the

free end, with a microscopic aperture at an end thereof, and reflecting means for reflecting light propagated from the light input/output end in such a manner that the light is guided towards the microscopic aperture, or reflecting light propagated from the microscopic aperture towards the light input/output end.

Paragraph beginning at line 11 of page 5 has been amended as follows:

Further, an optical microcantilever according to a second embodiment of [claim 2] the invention is an optical microcantilever for use with a scanning near field microscope[, comprising] and comprises an optical waveguide, having a light input/output end and a free end and a nose section at an angle with respect to an optical axis of propagating light passing through the light input/output end, for propagating light, a tip formed at the free end, with a microscopic aperture an an end thereof, and reflecting means for reflecting light propagated from the light input/output end in such a manner that the light is guided towards the microscopic aperture, or reflecting light propagated from the microscopic aperture towards the light input/output end.

Paragraph beginning at line 5 of page 6 has been amended as follows:

[The] In the optical microcantilever according to the first and second embodiments of the invention, [of claim 3 is the optical microcantilever of claim 1 or claim 2, where] at least part of the optical waveguide comprises a core, and a cladding is deposited on one side of the core, or both sides of the core, or is deposited so as to surround the core.

Paragraph beginning at line 15 of page 6 has been amended as follows:

[The] In the optical microcantilever according to the foregoing embodiments, [of claim 4 is the optical microcantilever of any one of claims 1 to 3, where] a light-blocking film is provided on the optical waveguide at the side where the tip is formed, and a reflecting film is provided at the opposite side to the side where the tip is formed.

Paragraph beginning at line 23 of page 6 has been amended as follows:

In order to achieve the aforementioned objects, a method, according to a first embodiment, of manufacturing an optical microcantilever [of claim 5] is a method for manufacturing an optical microcantilever for use with a

scanning near field microscope[, including] and includes the steps of forming a step to be taken as a mold for an optical waveguide at the substrate, depositing a reflecting film on the substrate, depositing an optical waveguide on the reflecting film, forming a tip by working the optical waveguide, depositing a light-blocking film on the optical waveguide, forming a microscopic aperture at the end of the tip, and forming a supporting section by having the substrate remain on the side to be a light input/output end and removing the substrate on the side to be the free end.

Paragraph beginning at line 23 of page 7 has been amended as follows:

[The] In the method of the first embodiment for manufacturing the optical microcantilever, [of claim 6 is the] [method of manufacturing the optical microcantilever of claim 5, where] an angle of the step formed [in the step forming step] is an angle enabling propagating light propagating from the light input/output end to be guided towards the microscopic aperture by the reflecting film deposited in the reflecting film depositing step, or is an angle enabling propagating light propagating from the microscopic aperture to be guided towards the light input/output end.

Paragraph beginning at line 12 of page 8 has been amended as follows:

In order to achieve the aforementioned objects, an optical microcantilever according to a third embodiment of [claim 7] the invention is an optical microcantilever comprising a cantilever constituted by an optical waveguide, a supporting section for the cantilever, th optical waveguide having a light input/output end and a free end, an optical element guide formed at the supporting section for deciding a position of an optical element acting on light entering the optical waveguide, and a channel provided between the light input/output end and the optical element guide.

Paragraph beginning at line 2 of page 9 has been amended as follows:

In order to achieve the aforementioned objects, a method, according to a second embodiment, of manufacturing an optical microcantilever [of claim 8] is a method for manufacturing an optical microcantilever for use with a scanning near field microscope, comprising the steps of forming a step to be taken as a mold for an optical waveguide at the substrate, forming an optical element guide at the substrate, depositing an optical waveguide on the substrate, forming a light input/output end of the optical waveguide,

forming a channel by working the substrate between the light input/output end and the optical element guide, exposing the optical element guide by removing the optical waveguide on the optical element guide, and forming a supporting section by having the substrate remain on the side to be a light input/output and removing the substrate on the side to be the free end.

Paragraph beginning at line 3 of page 10 has been amended as follows:

In order to achieve the aforementioned objects, a method, according to a third embodiment, of manufacturing an optical microcantilever [of claim 9] is a method for manufacturing an optical microcantilever for use with a scanning near field microscope, including the steps of forming a step to be taken as a mold for an optical waveguide at the substrate, forming an optical element guide at the substrate, depositing a reflecting film on the substrate, depositing an optical waveguide on the reflecting film, forming a tip by working the optical waveguide, depositing a light-blocking film on the optical waveguide, forming a microscopic aperture at the end of the tip, forming a light input/output end of the optical waveguide by removing the light blocking film, the optical waveguide, and the reflecting film, for the portion to

constitute the light input/output end of the optical waveguide[;], forming a channel by working the substrate between the light input/output end and the optical element guide, exposing the optical element guide by removing the light-blocking film, the optical waveguide, and the reflecting film on the optical element guide, and forming a supporting section by having the substrate remain on the side to be a light input/output end and removing the substrate on the side to be the free end.

Paragraph beginning at line 3 of page 12 has been amended as follows:

In order to achieve the aforementioned objections, an optical microcantilever according to a fourth embodiment [of] [claim 11] is an optical microcantilever comprising a cantilever-shaped optical waveguide, a tip formed at the free end of the optical waveguide and having a microscopic aperture at an end, thereof, wherein the optical waveguide comprises: a light input/output end at a fixed end thereof, a nose section formed between the free end and the fixed end at an angle with respect to an optical axis of the optical waveguide of the fixed end, and reflecting means for reflecting light propagating from the light input/output end in such a manner that the light is guided towards the nose section, and/or

reflecting light detected by the microscopic aperture and transmitted to the nose section towards the light input/output end.

Paragraph beginning at line 15 of page 12 has been amended as follows:

Further, [an] in the optical microcantilever of the fourth embodiment, [claim 12 is the optical microcantilever of] [claim 11, wherein] the optical waveguide has a head section at the end of the nose section extending substantially parallel with the optical waveguide of the fixed end, and the tip is formed at the head section.

Paragraph beginning at line 20 of page 12 has been amended as follows:

In order to achieve the aforementioned objects, the optical microcantilever according to any of the foregoing embodiments has [of claim 13 is the optical microcantilever of any one of claims 1 to 3, 11, or 12,] [wherein] a lens [is] provided between the tip and the reflecting means. [Further, the] [optical microcantilever of claim 14 is the optical microcantilever of claim 13]m [where] Preferably, the lens is a convex lens. [Moreover, the optical microcantilever of

claim] [15 is the optical microcantilever of claim 13 where]
Alternatively, the lens is a fresnel lens. Still further,
[the optical microcantilever of claim 16 is the optical
microcantilever of] [claim 13 where] the lens is preferably a
gradient-index lens.

Paragraph beginning at line 9 of page 13 has been amended as follows:

In order to achieve the aforementioned objects, in
the optical microcantilever according to any of the foregoing
embodiments, [of] [claim 17 is the optical microcantilever of
any one of claims 1 to 3, or 11 to 16,] [wherein] the tip of
the optical microcantilever employed in a scanning near field
microscope is formed of a material having a higher refractive
index than the optical waveguide.

Paragraph beginning at line 18 of page 13 has been amended as follows:

In order to achieve the aforementioned objects, an
optical microcantilever according to a fifth embodiment [of]
[claim 18] comprises a substrate, a cantilever-shaped optical
waveguide formed at the substrate, a tip, having a microscopic
aperture at an end thereof, formed at a side of the free end
of the cantilever, a light input/output end positioned at a

side of the fixed end of the optical waveguide, and an optical element guide, formed on the substrate on the side of the light input/output end, for deciding a position of an optical element acting on light entering the optical waveguide and on light exiting from the optical waveguide, wherein the light input/output end projects above the optical element guide.

Paragraph beginning at line 6 of page 14 has been amended as follows:

In order to achieve the aforementioned objects, an optical microcantilever according to a sixth embodiment [of] [claim 19] comprises a substrate, a cantilever-shaped optical formed at the substrate, a light input/output end positioned at a side of the fixed end of the optical waveguide, a tip provided at the side of the free end of the cantilever and having a microscopic aperture at an end thereof, and light-blocking means for ensuring that light scattered by the light input/output end is not transmitted in the direction of the tip.

Paragraph beginning at line 13 of page 14 has been amended as follows:

Further, [an] in the optical microcantilever of the sixth embodiment, [claim 20 is the optical microcantilever of]

[claim 19, wherein] the light-blocking means is arranged above the substrate and the optical waveguide, and provides a wall for blocking the scattered light.

Paragraph beginning at line 16 of page 14 has been amended as follows:

Further, [an] in the optical microcantilever of the sixth embodiment, [claim 21 is the optical microcantilever of] [claim 19, wherein] the light-blocking means comprises a light-blocking agent located on the substrate and the optical waveguide and a light-blocking film located on the light-blocking agent, and the light-blocking film is located in such a manner as to cover at least the light input/output end.

Paragraph beginning at line 21 of page 14 has been amended as follows:

Further, [an] in the optical microcantilever of the sixth embodiment, [claim 22 is the optical microcantilever of] [claim 19, wherein] the light-blocking means comprises[:] a light-blocking film located on the substrate and the optical waveguide and a light-blocking agent arranged so as to cover at least part of an end of the light-blocking film, and the light-blocking film is located in such a manner as to cover at least the light input/output end. [Further, an optical

microcantilever of claim 23 is the optical] [microcantilever of any one of claims 21 to 22, wherein] Preferably, the light-blocking film is movable.

Heading beginning at line 16 of page 17 has been amended as follows:

[Best Mode for Carrying Out the Invention] DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

IN THE CLAIMS:

Claims 1, 3 and 4 have been amended as follows:

1. (Amended) An optical microcantilever for [employed in] a scanning near field microscope, the optical microcantilever comprising:

an optical waveguide[,] having a light input/output end and a free end[,] for propagating light incident from the light input/output end;

a tip formed at the free end[,] of the optical waveguide and having [with] a microscopic aperture [at an end thereof]; and

a reflecting [means] member disposed at the free end of the optical waveguide and having a generally planar surface for reflecting light propagated from the light input/output end of the optical waveguide and for guiding the reflected [in

such a manner that the] light [is guided] towards the microscopic aperture[,] of the tip, or for reflecting light propagated from the microscopic aperture towards the light input/output end of the optical waveguide.

3. (Amended) [The] An optical microcantilever according to claim 1; [of any one of claims 1, 2, 11 and 12,] wherein at least part of the optical waveguide comprises a core[,] and a cladding disposed [deposited] on [one side of] the core[, or both sides of the core, or deposited so as to surround the core].

4. (Amended) [The] An optical microcantilever according to claim 3; wherein the optical waveguide has a first side on which the tip is formed and a second side opposite to the first side; and further comprising [of any one of claims 1 to 3, 11 and 12, wherein] a light-blocking film disposed [is provided] on the first side of the optical waveguide [at the side where the tip is formed,] and a reflecting film disposed on the second side of the optical waveguide. [is provided at the opposite side to the side where the tip is formed.]